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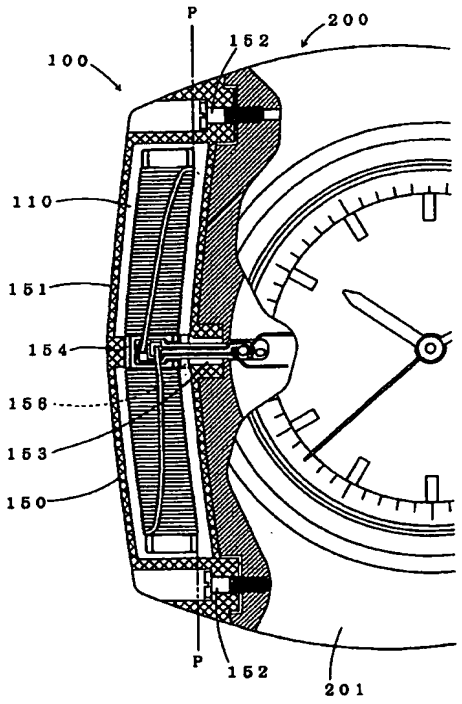
(54) ANTENNA FOR PORTABLE ELECTRONIC EQUIPMENT

(57) An antenna used for such portable electronic equipment as electronic watches, having a receiving function. The antenna (100) is bent in such a state that it fits the shape of the side section of a watch case (201). In addition the antenna (100) comprises an antenna element (110) and a case (150) for housing the antenna element (110). The case (150) is made of a nonmetallic material or coated with the nonmetallic material and it is separated from the watch case (201) made of a metallic material. Moreover, the antenna case (150) is fixed to the watch case (201) with screws (152) at positions distant from the extension line (P) of an antenna core (111).

Fig. 2



EP 0 703 513 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an antenna device used for portable electronic appliances furnished with a reception function, and, in particular, to such an antenna device suitable for being installed in an electronic wristwatch.

Description of the Related Art

In recent years there has been a remarkable growth in portable electronic appliances utilizing radio waves, and these have been commercialized in many fields. The field of wristwatches has been no exception, and, a wide variety of such appliances utilizing radio waves have been commercialized, including radio wave watches which automatically adjust the time to the standard time by receiving time signals from the standard wave, radio-equipped wristwatches, and the like. However, in order to utilize radio signals, it is necessary not only to provide parts which are quite different from conventional timepiece parts, but also to give adequate consideration to the interference by which the reception performance is affected.

Among these parts, particularly antenna, which has a significant effects on the radio signal reception performance, is considerably large in size as compared with the parts of conventional wristwatches. There are also restrictions imposed on the locations where the antenna is placed in relation to the reception performance. Because of these reasons, various types of antennas, such as built-in type, expansion type, and cord type are employed.

A bar-antenna comprising a core and winding is chiefly used as the built-in type antenna. It is necessary for the antenna to be enclosed in a wristwatch with no reduction in its reception performance due to the effects of the material of construction and the structure of the casing of the appliances. In the cases of expansion type antenna used for radio-casettes or the like, and a cord type antenna which is used as an earphone or the like as well, their retractability and durability must be taken into account.

In order to pursue further miniaturization and portability of these electronic appliances under this situation, not only avoiding reduction in the reception performance of the antenna is imperative, but also sufficient consideration must be given to their portability as well as to their design.

Conventional antenna constructions are then discussed taking particularly those used for a wristwatch as an example among various portable electronic appliances.

Conventionally, a wristwatch that has a metallic antenna arranged in the leather band has been known as a construction for installing an antenna in a wristwatch (Japanese Utility Model Laid-open (kokai) No. 126408/1990)

A wristwatch with unique design was disclosed in Japanese Utility Model Laid-open (kokai) No. 81787/1993 by the present inventors, in which an antenna consisting of a core and a coil wound around the core is placed between dial and windshield so as to separate the antenna from the metallic casing which interferes with the radio wave.

Further, another design is found in European Patent Publication No. 0382130, in which an antenna, for example, of a ring form is provided on the upper surface of the casing.

However, in the construction of the prior art wherein the antenna is provided in the band, it is impossible to provide a sufficient flexibility to the joining section of the antenna and the electronic watch module, because the antenna enclosed in the band must have condution to the electronic watch module in the casing. Furthermore, a special bands such as rubber bands must be provided, because metallic bands interfere with radio waves. This imposes restrictions on the materials of construction and the design.

On the other hand, the construction with an antenna installed on the upper surface of the casing requires the antenna to be separated from the metallic parts of the watch module. This increases the thickness of a watch as a whole and imposes restrictions on the design. Thus, it has problems still to be improved.

In the construction arranging a ring-form antenna on the upper surface of casing, disclosed in European Patent Publication No. 0382130, the antenna must be installed separated from the watch module, because radio waves cannot be received by the antenna if any metallic substance is present inside the ring.

Accordingly, an object of the present invention is to provide an antenna device which is free from these drawbacks possessed by conventional antenna devices used in portable electronic appliances, i.e. an antenna device exhibiting excellent reception performance without imposing any restrictions on its design.

Another object of the present invention is to provide an antenna device which, when it is applied to a wristwatch, prevents the wristwatch from becoming too bulky due to its thickness, thereby enabling the wristwatch to give a comfortable feeling to the wrist, while overcoming the drawbacks possessed by conventional antenna devices.

Disclosure of the Invention

The antenna device of the present invention is fabricated separately from a portable electronic appliance and assembled therein afterward. When this portable electronic appliance is a wristwatch, the antenna device is formed in a construction such that it can be installed on the side of the casing of the wristwatch conforming to the shape of the watch case.

The electronic appliances therefore do not become bulky, and thus there are no restrictions imposed on the design. When such an antenna is applied to a wristwatch, the wristwatch gives a comfortable feeling of wearing to the wrist.

In addition, the reception performance of the antenna of the present invention is promoted, because the antenna device of the present invention is enclosed in an antenna case either formed of or coated with a non-metallic material and installed apart from the watch case made of metallic material.

Furthermore, because the antenna device of the present invention has a bent antenna, it has an excellent directivity and can receive radio waves from various directions. The reception performance is thus further promoted.

Still further, because the antenna case is fixed to the watch case with screws at positions apart from the extended line of the antenna core in the antenna device of the present invention, reception interference by metallic screws can be avoided, resulting in further promotion of the reception performance.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view showing an external appearance of an electronic wristwatch to which the antenna device of the present invention is applied.

Figure 2 is a cross-sectional plan view of the antenna device of the first embodiment.

Figure 3 shows the antenna core in the antenna device of the first embodiment, wherein (A) is a front view, (B) is a bottom view, (C) is a cross-sectional side view along the line I-I, (D) is a cross-sectional side view along the line II-II, and (E) is a cross-sectional side view along the line III-III.

Figure 4 is a front view of a terminal sheet in the antenna device of the first embodiment.

Figure 5 is a front view of the antenna in the antenna device of the first embodiment.

Figure 6 is a cross-sectional view along the central part of the antenna case in the antenna device of the first embodiment.

Figure 7 is a plan view showing the relationship of the antenna and the circuit substrate in the timepiece module of the first embodiment.

Figure 8 is a breakdown view showing the antenna device of the second embodiment.

Figure 9 is a cross-sectional plan view of the antenna device of the second preferred embodiment.

Figure 10 shows the antenna in the antenna device of the third embodiment of the present invention, wherein (A) is the antenna core as disassembled, (B) is the antenna core as integrated, and (C) is the antenna as assembled.

Figure 11 is a cross-sectional view of the antenna device of the third embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE PRESENT INVENTIONS

The present invention will be now described in more detail with reference to the accompanying drawings, depicting embodiments in which the antenna of the present invention is applied to an electronic wristwatch.

Figure 1 shows an external appearance of an electronic wristwatch equipped with a preferred embodiment of the antenna device of the present invention. As shown in the Figure, the structure of this embodiment is composed of an antenna device 100 secured to a wristwatch 200 at the 9:00 o'clock side.

Illustrating first wristwatch 200, the wristwatch presented here possesses functions similar to an ordinary wristwatch, and various components of a watch, such as a dial 202, an hour hand 203, a minute hand 204, and a second hand 205, are enclosed and sealed in a watch case 201. On dial 202, a calendar display 206 and an AM/PM display unit 207, which displays different colors for AM and PM by a disc (not shown in the drawings) with two distinctly colored areas rotating under dial 202, are provided.

A first push-pull button 208, a second push-pull button 209, and a winding stem 210 are attached to the 3:00 o'clock side of the watch case 201. Here, the first push-pull button 208 is a time-correcting button, which may be used in countries where a summer-time system is adopted. Time correction of one hour can be performed by one-touch of this push-pull button. Second push-pull button 209 is an operating button for reception monitoring or for forced reception of radio waves.

Illustrating then antenna device 100, this antenna device 100 comprises, as shown in Figure 2, an antenna 110 and an antenna case 150, in which the antenna 110 is enclosed and secured to the 9:00 o'clock side of the watch 200.

Figure 3(A) is the front view of the antenna core, and 3(B) is the bottom view. The antenna core 111 is slightly bent as shown in Figure 3(A), so that the antenna core may conform to the outer curvature of the watch case 201 at its 9:00 o'clock side (the antenna case 150 is also bent as will be described later).

Antenna core 111 (also antenna case 150) can take any curved profile inasmuch as the curvature conforms to the shape of watch case 201 on the 9:00 o'clock side. Further, the shapes of antenna core 111 and antenna case 150 are not necessarily the same so long as antenna core 111 can be enclosed in antenna case 150.

The position for securing the antenna device is not necessarily limited to the 9:00 o'clock side. It can be secured on the 12:00 o'clock side or the 6:00 o'clock side.

When the antenna core 111 is bent in this manner, not only the directivity of the antenna is improved because the antenna can receive radio waves from various directions, but also a better watch design can be attained.

Antenna core 111 is formed integrally with a center frame 112, edge frames 113 at both ends of the core,

and wound sections 114, 114 between the center frame 112 and the edge frames 113. A terminal sheet groove 112a is formed on the upper surface of the center frame 112.

The antenna core 111 is formed, as shown in Figures 3(B), 3(C), 3(D) and 3(E), such that at least one of the surfaces along the longitudinal direction (both the front and bottom faces in this embodiment) constitutes one continuous flat plane. This is primarily because antenna core 111 is made of a ferrite material and formed integrally with a spool consisting of the center frame 112 and edge frames 113.

Specifically, antenna core 111 made of ferrite is first molded by means of metal injection, followed by defatting and burning on a level block. In this defatting and burning operation the antenna core 111 is designed so that its whole plane is brought to come into contact with the level block, because if the spool consisting of center frame 112 and edge frames 113 are projected, the indented wound sections may be hung down. This also makes contraction of antenna core 111 during burning uniform.

Terminal sheet 115 is formed rectangular, as shown in Figure 4, with a wire joining section 115a at one end and a circuit joining section 115b at the other end. Since the outer shape of wire joining section 115a is made to coincide with the shape of terminal sheet groove 112a of antenna core 111, terminal sheet 115 is automatically positioned when wire joining section 115a is engaged with terminal sheet groove 112a. When the terminal sheet 115 is thus positioned, the circuit joining section 115b is also automatically positioned at the joining point with the circuit substrate of the timepiece module (see Figures 2 and 7).

Winding 116 are individually wound around wound sections 114, 114 of antenna core 111, and both ends of winding 116 are connected to wire joining section 115a of terminal sheet 115. Thus, the signal received by the antenna is transmitted to the timepiece circuit from the central part of antenna core 111 through terminal sheet 115.

Center frame 112 of antenna core 111 and edge frames 113 at both ends of antenna core 111 function collectively as a spool and prevent the winding 116 from being loosened.

In addition, edge frames 113 at both ends of antenna core 111 are placed on the same axial line in parallel facing each other. Owing to this arrangement, antenna core 111 can be rotated as being supported by both ends when winding 116 is wound around antenna core 111. In this manner, winding operation can be carried out in a stable manner.

Antenna 110 is constructed in this manner, and appears as shown in Figure 5 when assembled. Since antenna core 111 is fragile, antenna 110 is housed in antenna case 150.

This antenna case 150 consists of a case body 151 and a cap 155 as shown in Figure 6, and made of a material which gives no interference with radio waves, such as non-metallic plastic, for promoting the reception performance.

The side of antenna case 150 where it keeps contact with wristwatch 200 has a shape corresponding to the shape at the 9:00 clock side of watch case 201, and as shown in Figure 2, antenna case 150 is secured to watch case 201 by being fixed with screws 152 at both ends of the case body 151. When metallic screws are used as screws 152, they are positioned apart from the extended line of antenna core 111, as shown in Figure 2, so that they do not interfere with the reception performance of antenna 110.

A connecting hole 153 is provided in the center of case body 151 at the watch case side as shown in Figures 2 and 6, and terminal sheet 115 is guided into inside watch case 201 through this connecting hole 153.

In the electric circuit of wristwatch, to which circuit joining part 115b of terminal sheet 115 is connected, an amplifier 211, IC 212, and the like for processing signals from the antenna are provided adjacent to circuit joining part 115b as shown in Figure 7. With this circuit arrangement, signals from the antenna can be processed before being affected by noises originating from motors 213-215, crystal oscillator 216, or condenser 217, and the like, thus preventing operational errors of the watch.

Further as shown in Figures 2 and 6, a stopper projection 154 is provided inside case body 151 at the position corresponding to center frame 112 of the antenna core, and another stopper projection 156 is also provided inside cap 155 at the position corresponding to center frame 112 of the antenna core. These projections 154 and 156 hold antenna 110 tightly between them and fix it so firmly that it does not move in antenna case 150. This prevents breakage of antenna core 111 and promotes stability of its reception performance.

The antenna device 100 thus constructed is positioned on the 9:00 o'clock side of watch case 201 and secured by screws 152, 152, as mentioned above.

Figures 8 and 9 show a second preferred embodiment of the antenna device of the present invention.

In this embodiment, antenna core 111 is formed from two separate core bodies 111a and 111b, and windings 116a and 116b are wound around each core body 111a and 111b. Terminal sheet grooves 112a and 112b are formed on one side of each core body 111a and 111b. These terminal sheet grooves 112a and 112b have the same shape as the wire joining part 115a of terminal sheet 115. Thus, when wire joining section 115a is engaged with terminal sheet grooves 112a and 112b, circuit joining part 115b of terminal sheet 115 is automatically positioned at intended joining position on the circuit substrate of the timepiece module.

On the circuit substrate of the timepiece module, terminals 221a, 221b and a lead section 222 are provided for connecting the left end of winding 116a and the right end of winding 116b. Therefore, windings 116a and 116b are made integral when the circuit joining part of the terminal sheet connected to winding 116a and the circuit joining part of the terminal sheet connected to winding

116b are joined together. In this manner, the antenna core 111 consisting of core bodies 111a and 111b, and the windings 116a and 116b altogether form one antenna 110.

In this instance, core bodies 111a and 111b are positioned with a prescribed angle which corresponds to the shape of the side of watch case 201. Further, antenna 110 is housed in antenna case 150, and both ends of core bodies 111a and 111b are fixed by stopper projection 154 of case body 151.

Because the antenna device of this second embodiment has an antenna core 111 formed in a simple bar-shape, it can be easily manufactured. In addition, winding operation can be performed comparatively easily, if a wire such as Bondmet wire is used.

Figure 10 shows a third preferred embodiment of the antenna device of the present invention.

Also in this embodiment, antenna core 111 is formed from two separate core bodies 111a and 111b, around which windings 116a and 116b are respectively wound, as shown in Figure 10(A). The opposing faces of core bodies 111a and 111b are shaped slant against the axial center of each core body.

Slanted sides of core bodies 111a and 111b, around which windings 116a and 116b are respectively wound, are pressed into ring sections 117a and 117b of a connecting bobbin 117, and firmly fixed with an adhesive. This enables the slanted ends of core bodies 111a and 111b to come contact with each other in connecting bobbin 117, thereby bringing the two core bodies 111a and 111b to be integrated by connecting bobbin 117 to form antenna core 111.

In this case, the integrated antenna core 111 is bent at a prescribed angle corresponding to the side shape of watch case 201 on account of the slope of the slanted side faces of core bodies 111a and 111b.

Wire joining section 115a of terminal sheet 115 is fixed to connecting bobbin 117 with an adhesive. By fixing wire joining section 115a in this manner, circuit joining part 115b of terminal sheet 115 is positioned at the joining point of the circuit substrate in the timepiece module. The left end of winding 116a and the right end of winding 116b are joined at wire joining section 115b, and the right end of winding 116a and the left end of winding 116b are joined to the circuit substrate in the timepiece module via wire joining section 115a and circuit joining section 115b.

In this manner, windings 116a and 116b are also integrated to constitute antenna 110 together with antenna core 111 (111a and 111b) and terminal sheet 115.

This antenna 110 is also housed within antenna case 150 as shown in Figure 11, and the upper and bottom sections of connecting bobbin 117 are fixed firmly between stopper projection 154 of case body 151 and stopper projection 156 of cap 155, in the same manner as in the first embodiment.

The antenna device of the third embodiment is also formed from two separate core bodies, each consisting of a straight bar, around which windings are wound. Because of this, manufacture of the antenna core and winding work can be facilitated.

FIELD OF INDUSTRIAL APPLICATION

As illustrated above, the antenna device of the present invention for portable electronic appliances is suitable for use as an antenna device of electronic wristwatches for receiving standard radio waves, electronic wristwatches equipped with built-in radio, and the like, or as an antenna device for portable communication tools, portable TVs, and the like.

Claims

1. An antenna device for a portable electronic appliance characterized by a construction that said antenna device is formed separately from said portable electronic appliance and installed on the side of said portable electronic appliance.

2. The antenna device for a portable electronic appliance according to Claim 1, wherein said portable electronic appliance is a wristwatch and said antenna device is installed on the 9:00 o'clock side of said wristwatch.

3. The antenna device for a portable electronic appliance according to Claim 2, wherein said antenna device is bent conforming to the shape of the 9:00 o'clock side of the watch case of said wristwatch.

4. The antenna device for a portable electronic appliance according to Claim 3, wherein said antenna device comprises an antenna which is bent conforming to the shape of the 9:00 o'clock side of the watch case, and an antenna case for housing said antenna which is bent conforming to the shape of the 9:00 o'clock side of the watch case.

5. The antenna device for a portable electronic appliance according to Claim 4, wherein said antenna case is made of a non-metallic material.

6. The antenna device for a portable electronic appliance according to Claim 4, wherein an antenna core of said antenna is formed integrally.

7. The antenna device for a portable electronic appliance according to Claim 6, wherein windings is wound around both sides of said antenna core, and a joining member is provided at the center of said antenna core for connecting the windings to the circuit in the timepiece module.

8. The antenna device for portable electronic appliances according to Claim 7, wherein a center frame is integrally formed on the center of said antenna core, and a groove for positioning the terminal sheet

which serves as said joining member is provided on one surface of said center frame.

9. The antenna device for a portable electronic appliance according to Claims 6, 7, or 8, wherein edge frames are integrally formed on both sides of said antenna core.

10. The antenna device for a portable electronic appliance according to Claim 9, wherein said edge frames are provided on the same line along the longitudinal direction of said antenna core in parallel facing each other.

11. The antenna device for a portable electronic appliance according to Claims 8, 9, or 10, wherein said antenna case is composed of a case body and a cap, and projections are provided on said case body and said cap for fixing the center frame of said antenna core.

12. The antenna device for a portable electronic appliance according to Claims 10 or 11, wherein at least one of the surfaces along the longitudinal direction of said antenna core formed integrally with said center frame and edge frames is made flat.

13. The antenna device for a portable electronic appliance according to Claims 2, 3, 4, or 5, wherein said antenna core is formed from two separate core bodies, which are placed with an angle corresponding to the shape of the 9:00 o'clock side of the watch case of a wristwatch.

14. The antenna device for a portable electronic appliance according to Claim 13, wherein the ends of windings wound around said antenna core are connected together on the circuit substrate in a timepiece module via a joining member.

15. The antenna device for a portable electronic appliance according to Claims 2, 3, 4, or 5, wherein said antenna core is formed from two separate core bodies, which are joined by a bobbin with an angle corresponding to the shape of the 9:00 o'clock side of the watch case of the wristwatch.

16. The antenna device for a portable electronic appliance according to Claim 15, wherein said ends of windings wound around said antenna core are connected together on the joining member.

17. The antenna device for a portable electronic appliance according to Claims 15 or 16, wherein said antenna case is composed of a case body and a cap, and projections are provided both on said case body and said cap for fixing said connecting bobbin.

18. The antenna device for a portable electronic appliance according to Claims 4, 5, 11 or 17, wherein said antenna case is fixed to the watch case with screws at positions apart from the extended line of the antenna core.

Fig. 1

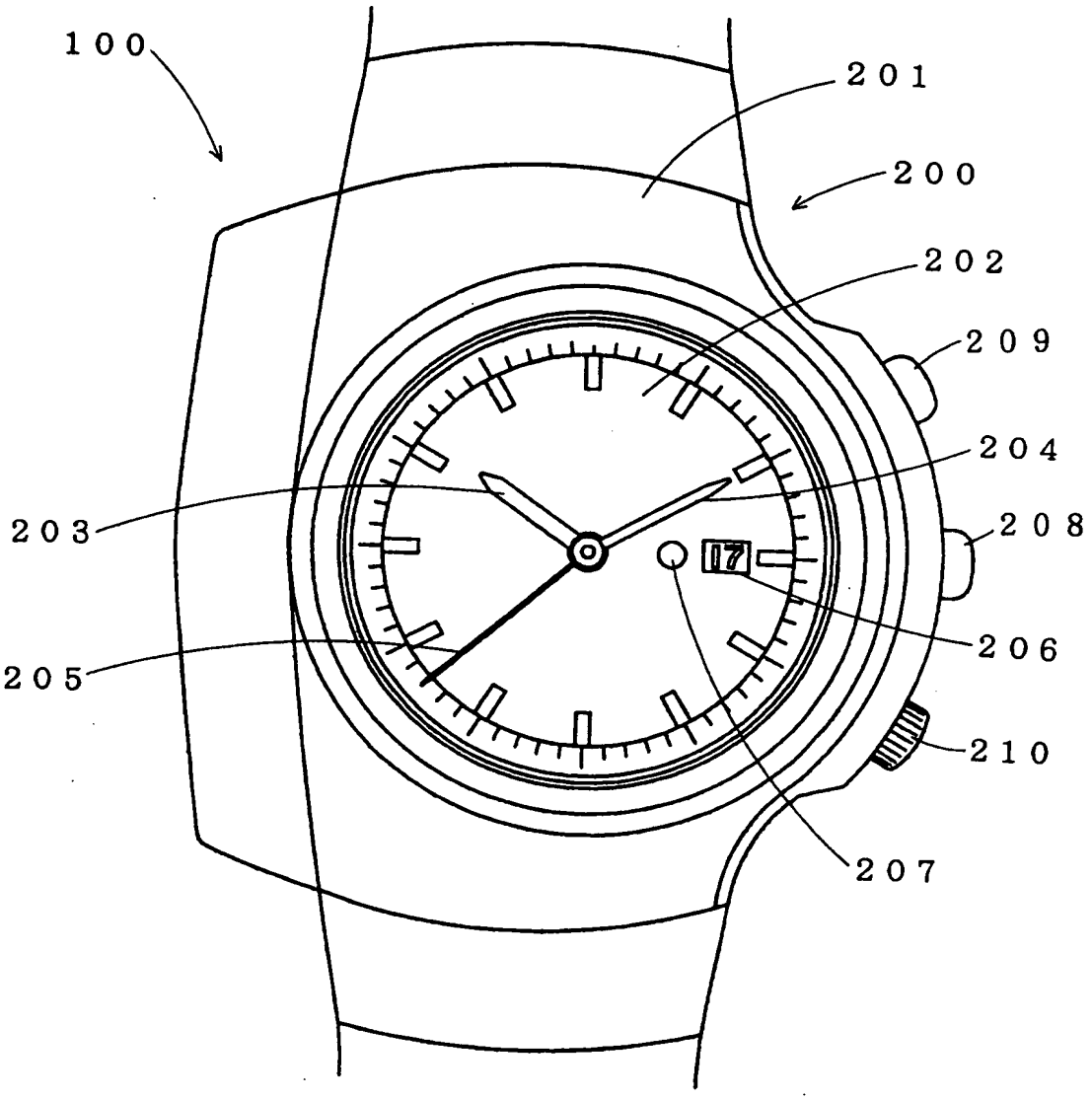


Fig. 2

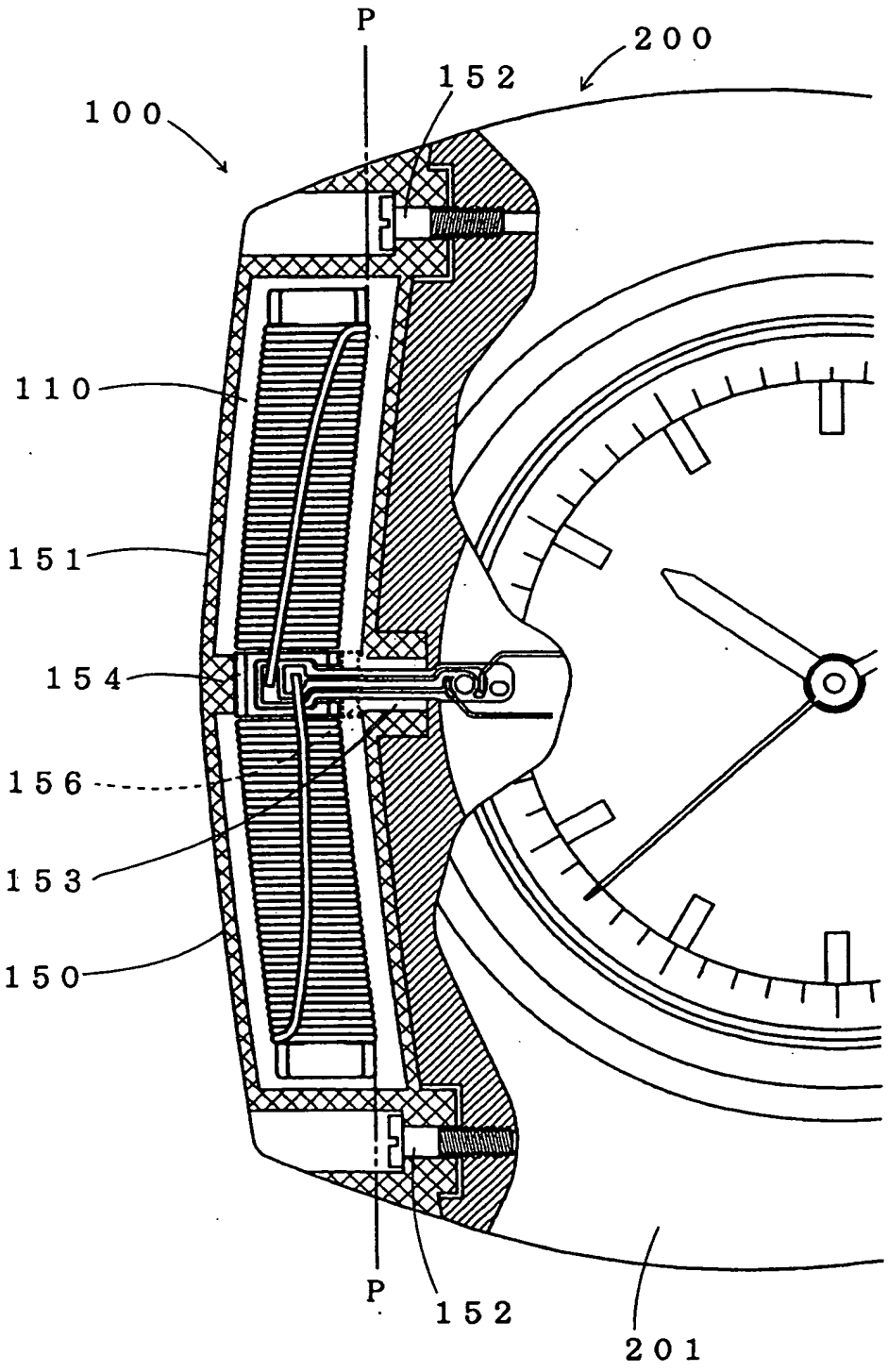
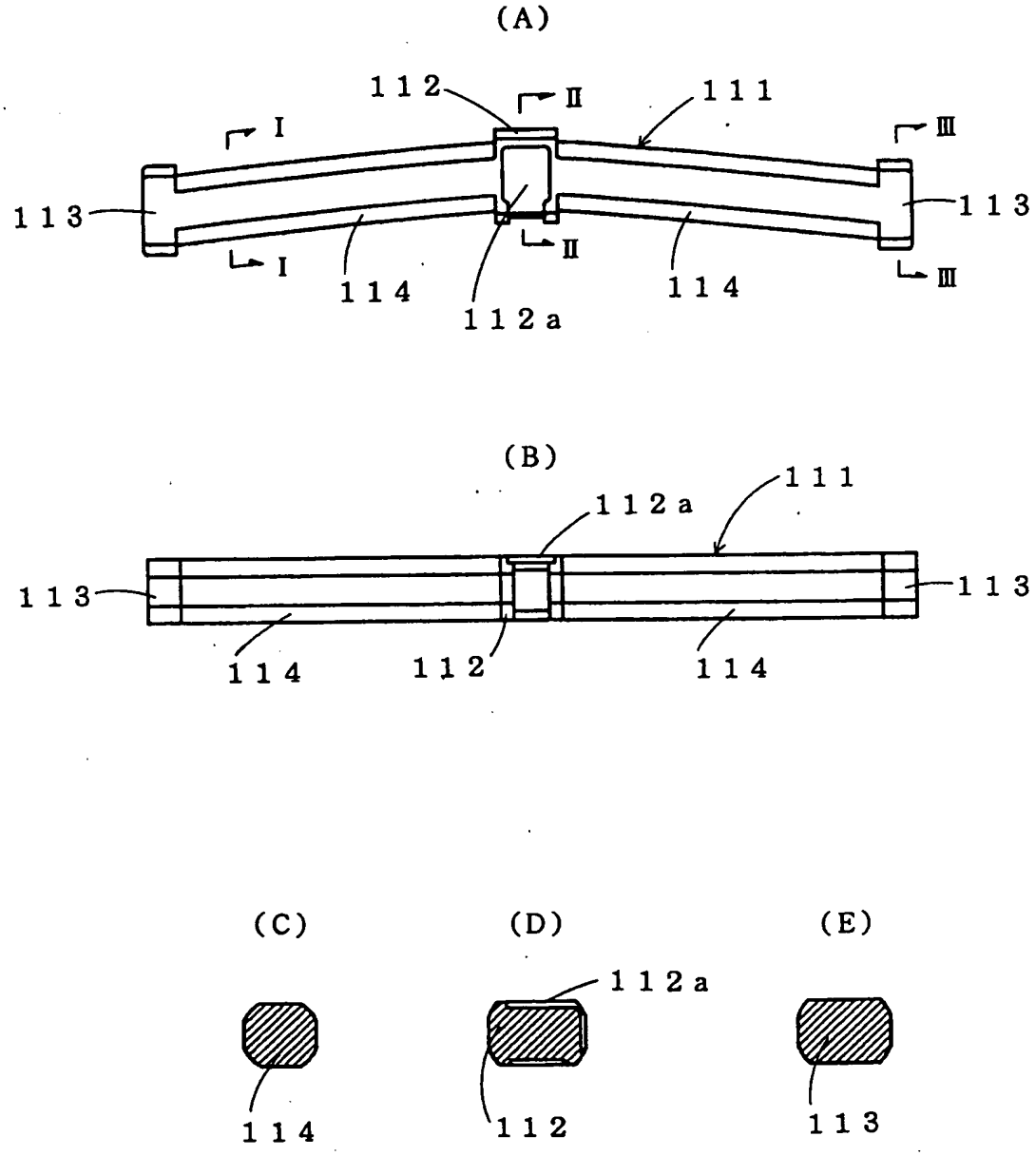


Fig. 3


(A)
112
II
111
I
III
113
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II
III
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112a
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(B)
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(D)
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Fig. 4

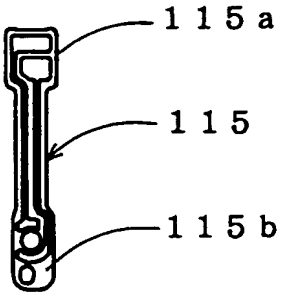


Fig. 5

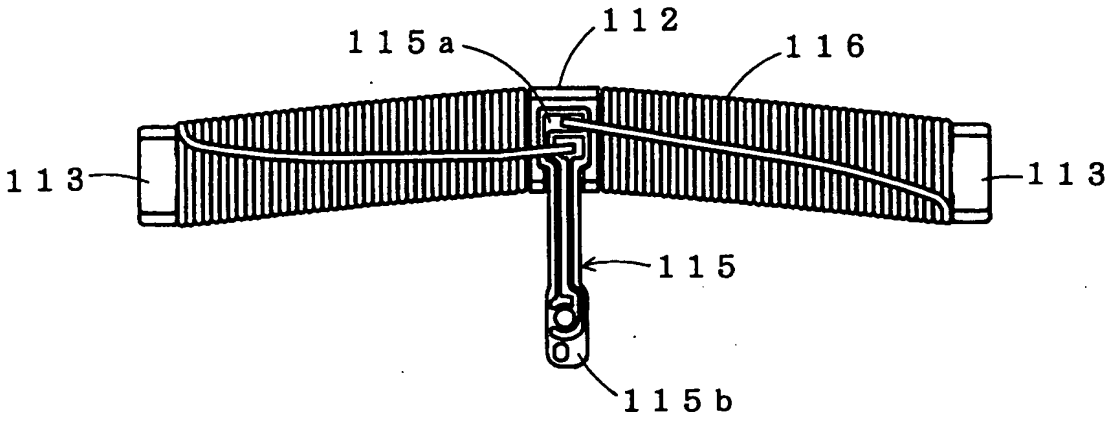


Fig. 6

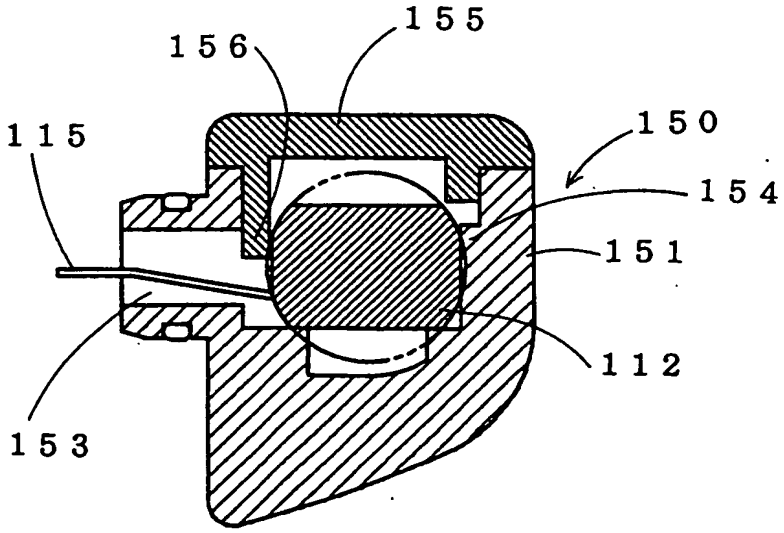


Fig. 7

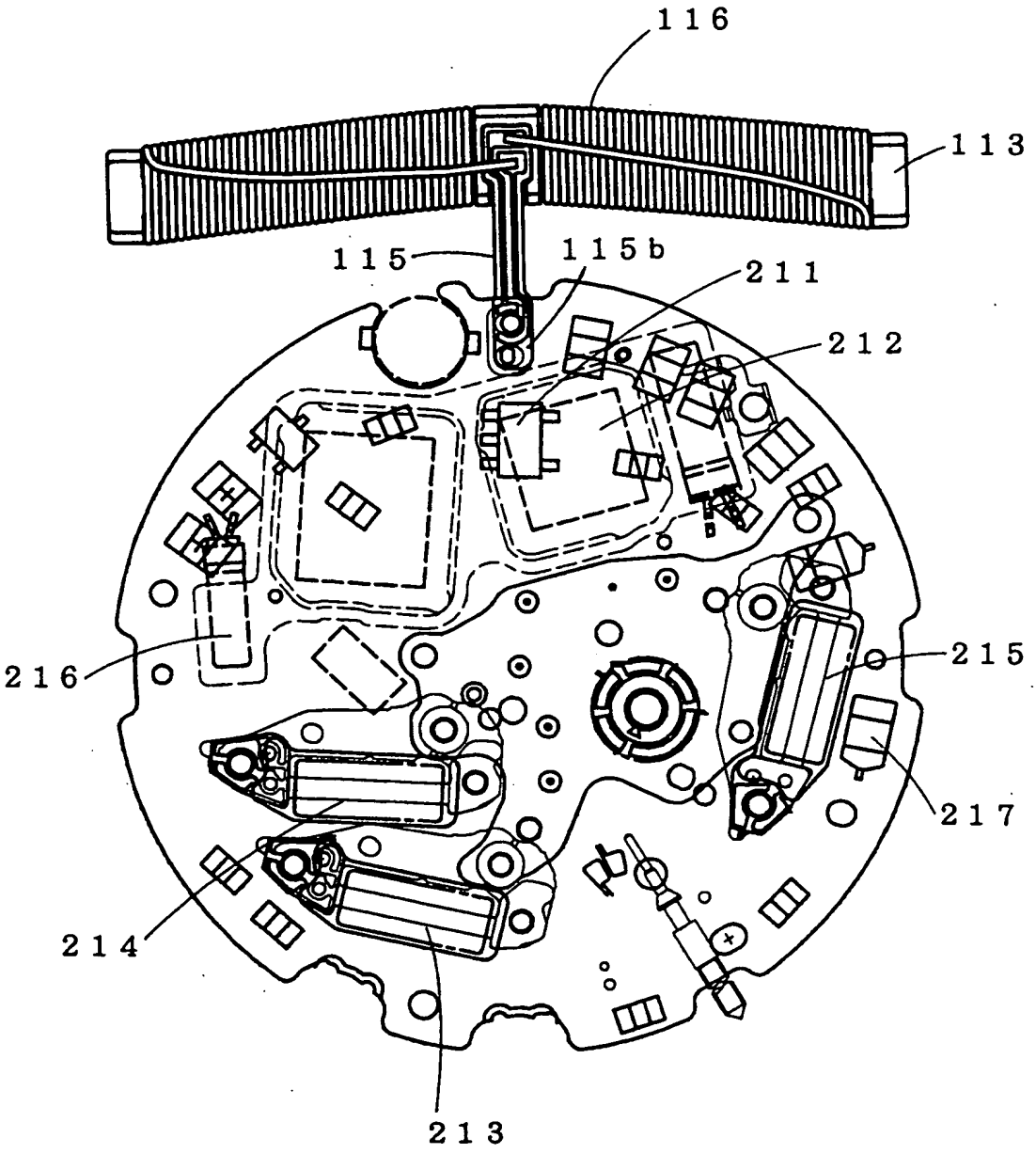
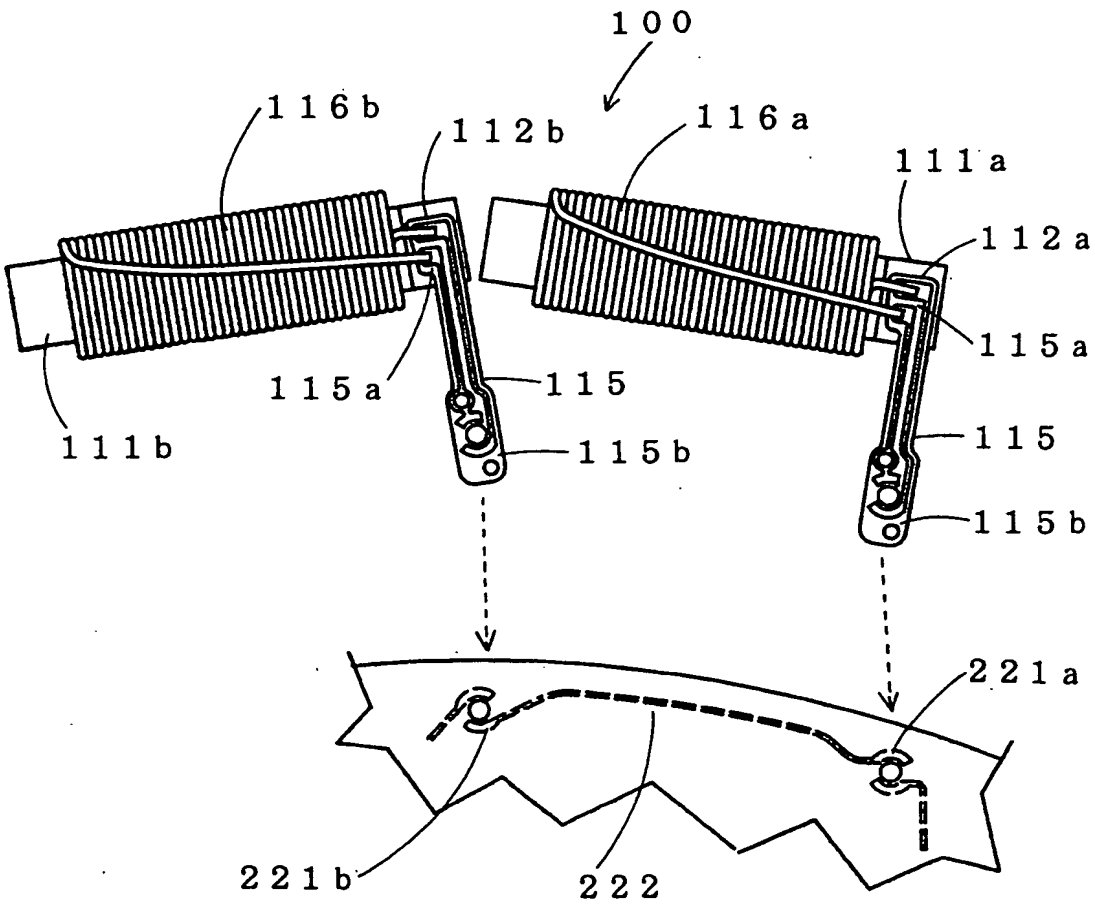


Fig. 8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221b
222

Fig. 9

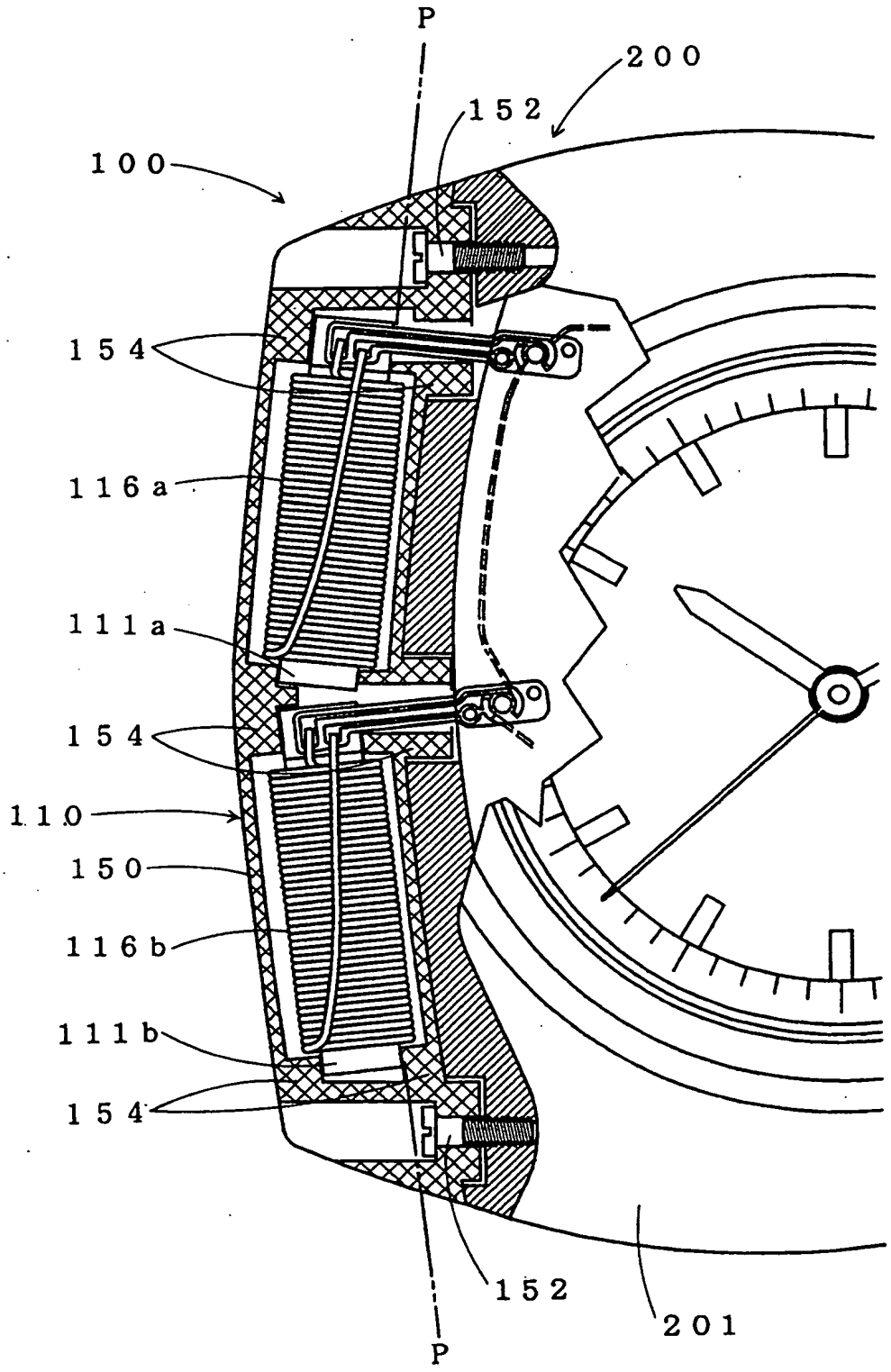
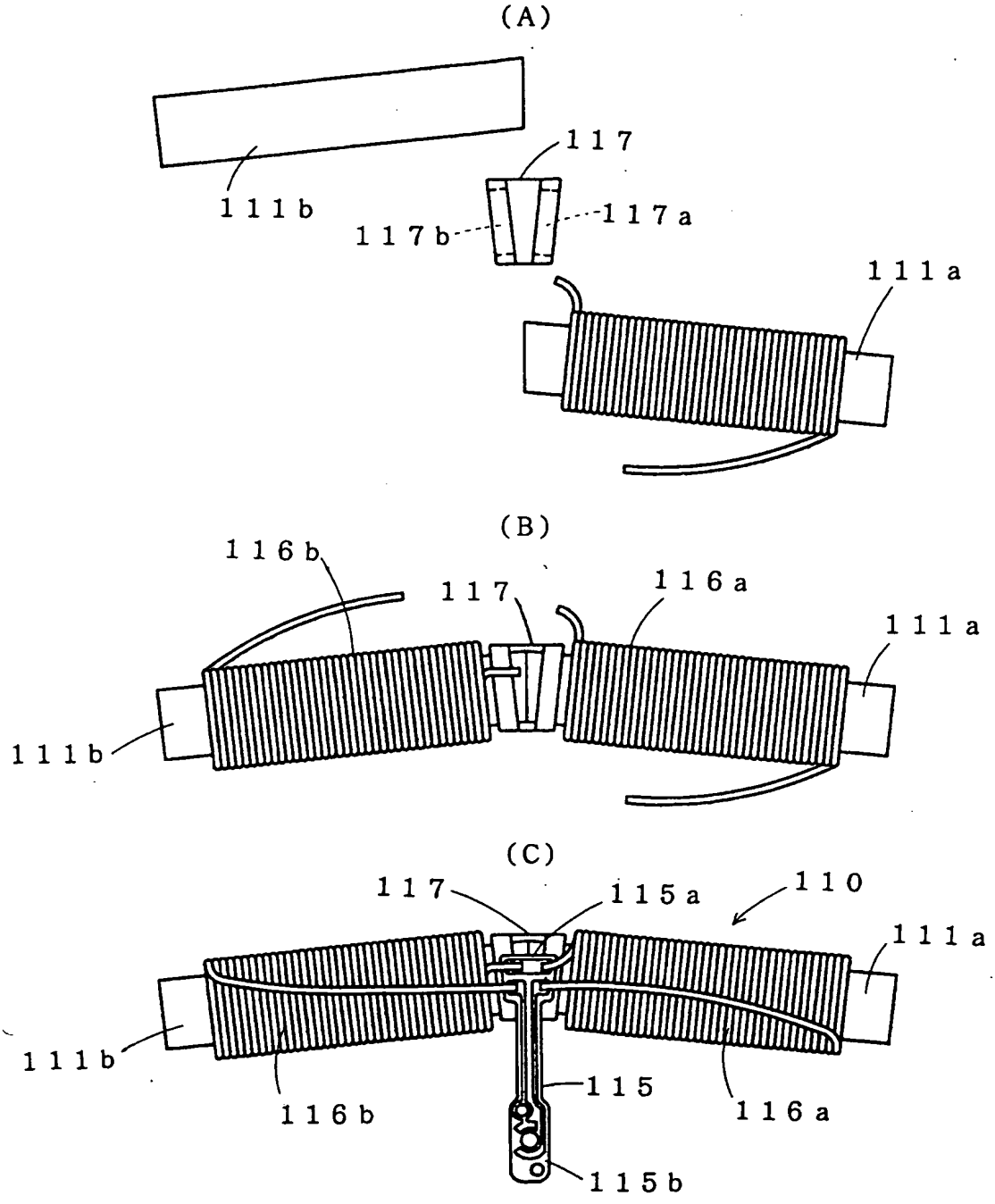


Fig. 10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116a
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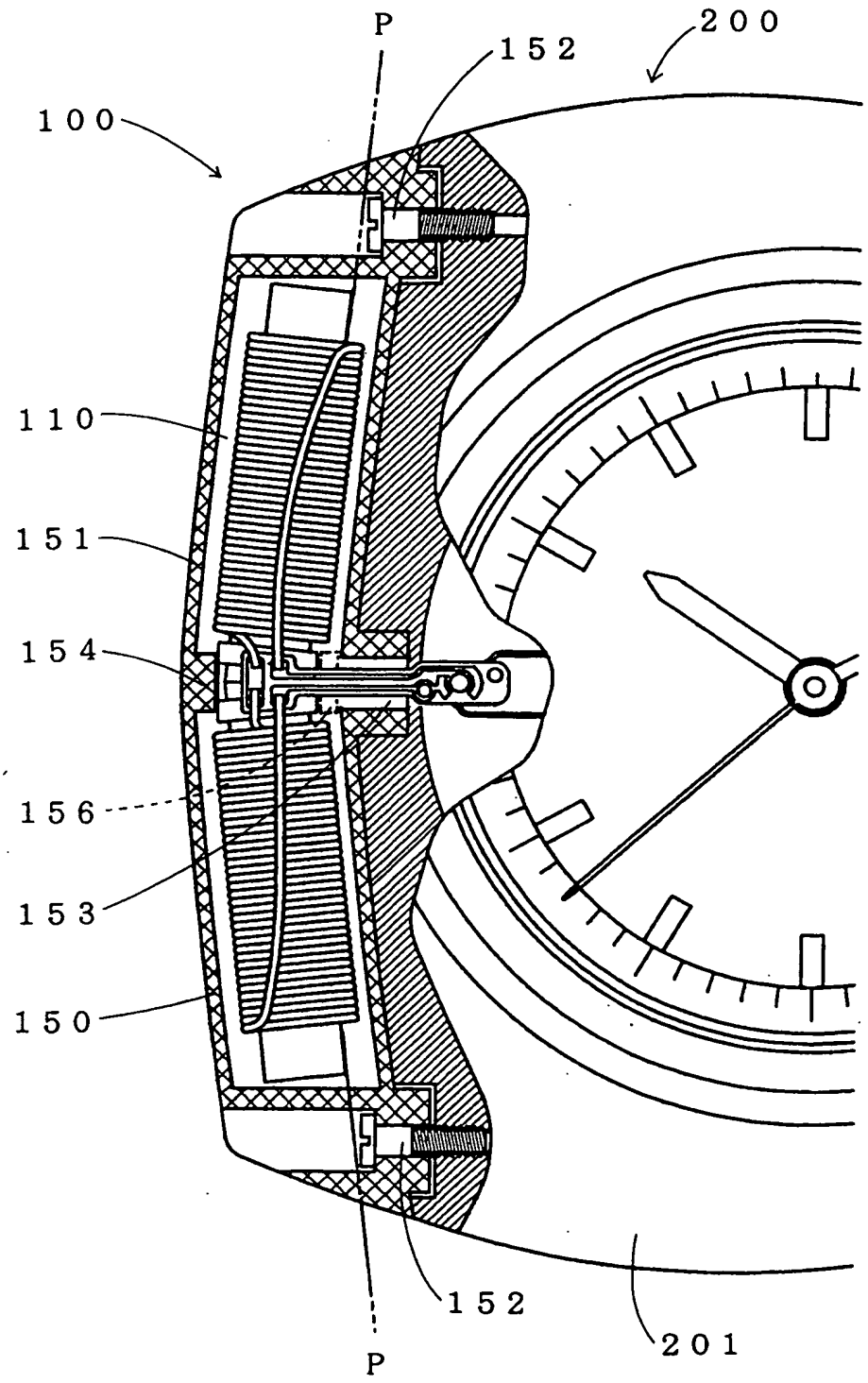
Fig. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP94/01219

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 G04G1/00, G04C11/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^5 G04G1/00, G04C11/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1926 - 1993
Kokai Jitsuyo Shinan Koho 1971 - 1993

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 5200/1990 (Laid-Open No. 95996/1991) (Seiko Instruments Inc.), September 30, 1991 (30. 09. 91), Lines 2 to 7, page 5, Fig. 1, (Family: none)	1-2 3-7, 13-16 8-12, 17-18
X Y A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 17292/1981 (Laid-Open No. 132282/1982) (Daini Seikosha K.K.), August 18, 1982 (18. 08. 82), Line 10, page 2 to line 3, page 3; Figs. 1 to 3, (Family: none)	1-2 3-7, 13-16 8-12, 17-18
X Y A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 17290/1981 (Laid-Open No. 132281/1982) (Daini Seikosha K.K.), August 18, 1982 (18. 08. 82), Line 6, page 2 to line 4, page 3; Figs. 1 to 2,	1-2 3-7, 13-16 8-12, 17-18

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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Date of the actual completion of the international search	Date of mailing of the international search report
December 27, 1994 (27. 12. 94)	January 31, 1995 (31. 01. 95)
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP94/01219

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	(Family: none)	
Y A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 23823/1991 (Laid-Open No. 114094/1991) (Seiko Instruments Inc.), November 22, 1991 (22. 11. 91), Lines 11 to 18, page 3, Figs. 1 to 2, (Family: none)	1-7, 13-16 8-12, 17-18
Y A	JP, A, 55-91237 (Suwa Seikosha K.K.), July 10, 1980 (10. 07. 80), Line 15, upper left column, page 3 to line 11, upper right column, page 4, Fig. 1, (Family: none)	1-7, 13-16 8-12, 17-18
Y A	JP, U, 54-91163 (Daini Seikosha K.K.), June 27, 1979 (27. 06. 79), Fig. 1, (Family: none)	1-7, 13-16 8-12, 17-18
Y A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 95154/1990 (Laid-Open No. 53590/1992) (Seiko Instruments Inc.), May 7, 1992 (07. 05. 92), Line 15, page 4 to line 14, page 5; Figs. 1 to 2, (Family: none)	13-16 17-18
Y A	JP, Y, 55-8967 (Matsushita Electric Ind. Co., Ltd.), February 27, 1980 (27. 02. 80), Line 23, column 2 to line 5, column 3; Fig. 3 & US, A, 4,001,830 & NL, A, 760,224 & FR, A, 2,282,753 & DE, A, 2,536,873 & GB, A, 1,494,655 & CA, A, 1,044,365 & IT, B, 800,110	7 8-12
A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 18457/1981 (Laid-Open No. 132286/1982) (Daini Seikosha K.K.), August 18, 1982 (18. 08. 82), Lines 4 to 20, page 3; Figs. 1 to 3, (Family: none)	1-18